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A NEW THEORY OF SCRIBBLING AND DRAWING IN CHILDREN.

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INFANT SCRIBBLING ACTIVITY IS NOT SIMPLY PLAY. IT CONTRIBUTES TO THE DEVELOPMENT OF VISUAL ATTENTION AND PERCEPTION. YET, SCRIBBLING, UNLIKE WRITING IN THE COMMUNICATION SENSE, IS NOT MOTIVATED BY THE DESIRE TO INFORM, NOR TO SET DOWN THOUGHTS AND FEELINGS. THE EXPERIMENTAL HYPOTHESIS OF THIS STUDY WAS THAT THE MOTIVATIONS FOR SCRIBBLING ARE (1) MAKING A MARK OR TRACE ON THE PAPER, (2) CONTROLLING THE VISUALLY PERCEIVED TRACE, AND (3) SIMPLY PERCEIVING THE TRACE, NOT THE MOTOR STIMULATION INVOLVED IN THE ACT OF SCRIBBING. TO TEST THIS HYPOTHESIS, 14 INFANTS, 15 TO 38 MONTHS OF WRITE AND THE OTHER WOULD NOT. THE ORDER OF USE OF THE 2 INSTRUMENTS WAS VARIED SO THAT SOME INFANTS SCRIBBLED FIRST WITH THE TRACING AND SOME INFANTS FIRST WITH THE NONTRACING, INSTRUMENT. THE SCRIBBLING ACTIVITY WITH BOTH INSTRUMENTS WAS TIMED. IN THE CASE OF ALL 14 CHILDREN, USE OF THE NONTRACING INSTRUMENT REDUCED SCRIBBLING TIME AN AVERAGE OF 2/3. IN A SECOND, RELATED EXPERIMENT, 4 3-YEAR-OLDS WERE ASKED TO DRAW IN THE AIR. AGAIN, THE HYPOTHESIS TESTED WAS THAT REINFORCEMENT AND MOTIVATION FOR SCRIBBLING ACTIVITY WAS THE TRACE, AND NOT THE KINESTHETIC STIMULI. NONE OF THE CHILDREN WOULD DRAW IN THE AIR, ALTHOUGH THEY DID ASK FOR PAPER ON WHICH TO DRAW SOMETHING THEY COULD SEE. (WD)

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A New Theory of Scribbling and Drawing in Children

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"The studies that have been made of the development of scribbling in young children are not very revealing, except to show that children seem to enjoy it. But scribbling is not simply play, or an opportunity for the child to 'express himself;' it is an opportunity for the educating of visual attention and for learning to perceive in new ways" (Gibson, 1966, p. 230). It was predicted from this formula that young children who would scribble with an ordinary crayon or pencil would refuse to continue scribbling when given a special crayon or pencil that left no visible trace. The making of traces on a surface, the controlling of the displayed trace, and the seeing of these new display-variables were assumed to motivate the act of scribbling, not the transient feedback from the activity itself. A test of this prediction is made in the first experiment to be reported.

A second prediction was that young children at the scribbling age would be relatively unwilling to "draw a picture in the air" with a pencil when asked to do so, although older children are known to comply with such a request. The common hypothesis that scribbling yields satisfaction as a motor activity implies that younger children would be at least as willing to do so as older ones. The following tabulation lists the response-produced stimulation arising from each of the three different acts being studied.

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	Normal scribbling	Traceless scribbling	Drawing in air
Kinesthesis from joints and muscles	present	present	present
Visual motion of hand and tool	present	present	present
Pressure of tool on skin of hand	present	present	present
Resistance and friction of tool on surface	present	present	absent
Trace of moving tool on surface	present	absent	absent

The first four kinds of input ("reafferent" input or "feedback") are transient inasmuch as they cease when the act ends. The last, however, involves a source of visual stimulation that outlasts the act, and this is assumed to be critical. (For a more elaborate analysis of proprioception and haptic sensitivity, see Gibson, 1966, ch. 6-7).

The background of these experiments is a theory of the development of graphic activity and of pictorially mediated perception in the child and the human species (Gibson, 1966, ch. 11). The theory postulates a "fundamental graphic act." Examples of it are scribbling or finger painting which leave deposits on a surface, and scratching or grooving which leave indentations on a surface. Any surface thus altered provides a new source of visual stimulation, that is, a display in the general meaning of the term.

Experiment I

The hypothesis to be tested is that children will be unwilling to move a stylus against a surface when they discover that it does not leave a trace, as compared with doing so when it does leave a trace, despite

the equivalence of the two acts in all other respects. The relative amount of time spent scribbling with each of the tools, then, is the principal index of motivation in this experiment. With such an index, it is possible to observe both verbal and preverbal Ss. A range of different ages and different amounts of scribbling experience was sampled to bring out possible developmental differences.

Method. Two identical manual tools, only one of which produced a trace, were compared. After exploring various possibilities, the non-tracing tool was made from a wooden dowel, painted and shaped to look exactly like the tracing tool, which was a large, No. 2 lead pencil. Care was taken to make the tools equally sharp. (The experimenter could not distinguish between them on the basis of tactual feedback alone.) Double sheets of white paper, 11½" x 17", were taped to masonite boards of the same size. Ink embedded in the second sheet was released by pressure applied to the first; thus a record of the movement of the non-tracing tool was obtained, although it was not visible to the child when he used the stylus.

Fourteen children, ranging in age from 15 to 38 months (mean age 28 months) were observed in their homes in a free play situation, with the mother and occasionally an older sibling present. Two Es were necessary to run the experiment, one to keep time during the sessions, the other to direct the child's activity. To avoid creating a test-like atmosphere, instructions were minimized; the Es simply explained that they had brought some toys along because "they liked to watch children play." When rapport had been established, the child was seated at a table, on the floor, or in his mother's lap. The active E placed a

paper-and-board before him and then handed him one of the tools, remarking that it was a "very nice pencil." Most Ss proceeded to scribble without further instruction; a few of the younger Ss responded only after a short demonstration of scribbling by E or by an older sibling. Each child was given a session with both tools, the order of presentation being alternated from S to S.

A stopwatch was started when S began to scribble and was stopped during those intervals when he was not scribbling. It was not stopped when he momentarily paused to point out aspects of the scribble or talk about it. These latter pauses were very short, and since they occurred consistently and seemed to indicate interest in the task, they were considered as part of the time that the S engaged in scribbling. The session was terminated when S said he was finished, or when he asked for another piece of paper, or stopped scribbling. However, if he wished to end the session before 10 seconds had elapsed, he was encouraged to "play a little longer." If S had scribbled for 90 seconds, he was told to tell E when he was finished so he might be given some new material. (Pretests revealed that younger Ss were inattentive during the second session if permitted to scribble for more than 90 seconds during the first.) In the case of younger Ss who were either unable or unwilling to verbalize their wish to stop, repeated rejection of the tool or inattentiveness were taken as the criterion for ending the session; this procedure resulted in a slight overestimation of very short sessions. In most cases, S was not aware that the session was being timed, since the E who operated the stopwatch sat at some distance from him.

Results. Table 1 shows the length of time in seconds during which each child engaged in scribbling with the tracing tool and the nontracing tool. Children are listed in order of increasing age. For all Ss, elimination of the trace significantly reduced scribbling activity; the means were 71.7 seconds with the tracing tool and 20.6 seconds with the nontracing tool ($t = 5.35$, d.f. = 13, $p < .001$ 2-tailed).

Insert Table 1 about here

The following observations also support the hypothesis that a lasting trace must occur if scribbling is to be motivated. When using the tracing tool, Ss often called attention to their scribbles by pointing or naming, but this typical behavior did not occur when the tool left no trace. This is not surprising, but it shows the hypothesized importance to the child of the external display. The common reactions to the nontracing tool included (1) frequent examination of the tool or the paper, (2) increased pressure as judged by the heavier impressions left by the carbon sheet, (3) puzzled looks at the E, and (4) distractableness. Furthermore, eight Ss made the source of their confusion explicit with such remarks as "This one can't work," "It's broken," or "This doesn't got ink!" It was also noted that, whereas scribbling without accompanying visual attention to the paper was rare, it occurred more often when the nontracing tool was used. Two Ss, for example, having discovered that the tool did not produce a trace, continued to move it very slowly across the paper but watched the E instead of the paper in a disconcerted manner. It was as if they expected some further trick to be played on them. Finally, there was a fairly consistent tendency for Ss to produce vertical

or horizontal back and forth strokes with the nontracing tool, however complicated or advanced were their scribbles with the tracing tool. A possible interpretation of this finding would be that Ss revert to a more primitive form of scribbling when using the nontracing tool (Lowenfeld and Brittain, 1964) but a simpler explanation is that the back and forth motion is simply the common procedure for "making a pencil write."

The data can be expressed as the ratio of the time employed with the nontracing tool to the time employed with the tracing tool. These ratios are also presented in Table 1. The average amount of time spent with the nontracing tool was only one-third that spent with the tracing tool. We might have predicted that, if children scribble in order to achieve traces, they would not use the nontracing tool at all. This hypothesis was verified in four cases, numbers 6, 7, 12, and 13. These children stopped immediately as soon as they discovered that the tool did not "work." But the children had been implicitly instructed to scribble by being asked to play with paper and with what appeared to be a pencil. Subject 11, for example, was very acquiescent, acting only at E's suggestion during the entire session. Although she scribbled with the nontracing tool longer than any other child, when asked at the end of the session whether she liked that "pencil," she said she didn't like it because "it didn't write." Moreover, any experience with pencils should create expectations of being able to make the pencil produce traces, and some time might be required to discover that the nontracing tool could not be made to do so.

Our hypothesis asserts that scribbling is motivated from the outset by the immediate satisfaction of seeing a trace or display. An

alternative hypothesis is that scribbling has only an "activity motive" at the outset; that the child has to learn by association to expect a trace following on the manipulation, after which the trace might contribute to the motivation. On this latter hypothesis, tolerance of the nontracing tool should decrease with age and experience. However, the correlation between age and such tolerance is not significant ($r = -.40$), although a slight trend in the appropriate direction is evident. This is not enough evidence to suggest that the satisfaction of seeing a trace depends on a learned expectation. There is other evidence, on the contrary, suggesting that the satisfaction is immediate and automatic. The behavior of the 16-month-old S (number 2) is regarded as particularly significant here, since she had had no experience with tracing tools prior to our observations (although she may have watched her older brother scribbling). The child was first given the nontracing tool but could not be induced to scribble, even in imitation of her brother. She was next given the tracing tool. She responded as before--waving the tool and occasionally striking the paper with it--until an apparently fortuitous look at the paper as she pounded it with the stylus. From that moment the child scribbled, with great interest and increasing control. Although she had previously gripped the tool in her fist, she came to hold it overhand style. E presented the nontracing tool a second time at the first pause in the child's activity, since it was feared that her attention would wander before a comparison of the two tools could be made. This session was shorter and the child reverted to pounding the paper. It seems, then, that although she had not been taught the use of pencils nor the process of creating "pictures," her interest lay in the production

of traces. When they were not forthcoming, scribbling stopped. It is likely that we observed in this child the first manifestation of scribbling, and this seemed to be a discovery of the "fundamental graphic act."

Experiment II

A test of the hypothesis that children scribble so as to carry out motor activity for its own sake would be to ask them to draw in the air with a tracing tool. They should be willing to do so, even after scribbling has developed, if the act originated in this way. Motor kinesthesis from joints and muscles is the same as in trace-making and the "visual kinesthesis" of seeing the hand-and-tool move is also the same. The grasp of the tool is the same. The visual contact of the tool with the surface is absent and the haptic feeling of pressure on the surface and friction over the surface is absent. The gesture as such, however, remains, although the recording of this gesture on the surface has been eliminated.

In order to test this prediction, four three-year-old nursery-school children were asked the following questions:

Do you ever draw pictures in the air?

Can you make a picture of a (ball, or other appropriate object) in the air with this pencil?

Show me how you do it.

If you pretend that there is a big piece of paper here, can you draw a picture? (Why not?)

Do you think this is a good way to make pictures? (E gesturing with pencil.)

All of the children refused to draw in the air, even when told to "make believe" that paper was present. They did not seem to approve of it. These results cannot be attributed to a general unwillingness to perform; all of the children asked for paper on which to draw a "real" picture, one which they could "see." This confirms our own prediction, and casts further doubt on the hypothesis that scribbling is a purely motor activity or that it begins as one.

Discussion

The theory that perception is based on the pickup of information, not on the organizing or interpreting of sensations (Gibson, 1966) distinguishes between direct or immediate perception of the environment and indirect or mediated apprehension based on human artifacts or "surrogates." The former affords perception at first hand; the latter provides for a kind of perception at second hand. Graphic art in general, pictures and drawings in particular, and the special case of writing are all types of man-made sources of stimulus information that permit mediated perception (Gibson, 1966, ch. 11. See also Gibson, 1954, for an earlier version of the theory). Art, picturing, and writing have all developed in man during the last twenty or thirty thousand years. Presumably they all have their root in trace-making and this is why the "fundamental graphic act" is psychologically important. It is probably also important in the development of the child. The foregoing experiments tell us something of its motivation.

The development of display-making in the child. The act of scribbling, daubing, finger-painting, scratching, or altering a plastic

surface is not at the outset an act of communication or a social act. It seems to be an act with the sole purpose of producing a new source of optical stimulation that can be looked at by its producer and that continues to be visible. It displays his handiwork. It continues to be visible, of course, not only to him but to others, and the child soon wants others to look at his scribbles, but the trace making begins as a controlled sequential changing of the reflecting capacity of a surface. The trace converts a movement in time into a frozen form in space, and the form is even more interesting to see than the movements of the hand in the air. The latter is a transient feedback that occupies the attention of younger infants.

The graphic act continues to be interesting in later life. The "doodling" of adults has at least this much in common with the work of non-representative painters: it is an exercise in producing and discriminating optical structures. It is good practice in perceiving but it is not communication.

The development of depicting in the child. The fundamental graphic act soon begins to differentiate. Parents encourage the child to "draw things." They would like to think that he can "draw from memory" and represent what he knows. The adult perceives outlines on paper as he would the discontinuities in an optic array that specify the physical edges of objects in the world (the figure-ground phenomenon). Hence any slight resemblance between outlines on paper and the edges of an object meets with parental approval. Eventually the child himself will begin to detect that the edge-information in light can be partly reconstituted

by a linear trace, and this helps him to discriminate straightness, curvature, bentness, tilt, and the openness or closedness of lines. These discriminations are necessary if he is later to perceive writing and printing.

The child has been naively registering the physical edges of objects all along, but now he may begin to notice the perspectives of these edges, the perspectives of balls and boxes, of houses, faces, men, and animals. They are not, of course, frozen in time like his tracings on paper but ever-varying. Nevertheless if he holds still he can freeze them. If he notices this he will begin to be able to take the pictorial attitude. This is a special kind of attention, quite different from his ordinary attention only to the formless invariants of things.

The origin of depicting in our prehistoric ancestors was not, of course, helped by encouragement from the elders. The first cave-painter had to discover for himself the equivalence of lines to edges. But when he did, and when he found that he had made a mammoth, say, appear on the wall of a cave, he must have been astonished, and it must have seemed magical (Gibson, 1966, p. 228 ff). He had been scribbling and finger-painting, one can be sure, long before he made this discovery.

The development of writing in the child. When scribbling has sufficiently elaborated, and when the seeing and producing of line qualities has progressed, the stage is set for the child to learn the skill of alphabetic reading and writing. Reading is perceptual while writing is motor, we say, but the two aspects of literacy cannot be separated, except arbitrarily. The ability is much more demanding than that required

for pictorial recognition and pictorial communication since it requires an extra stage of mediation. Pictures freeze some of the direct information about the environment in light, whereas writing freezes speech, which is already indirect information. The child learns to read and write much later than he develops the ability to see and make pictures. Similarly, our human ancestors invented alphabets much later than they did pictures.

The development of mediated cognition in the child. Pictorially mediated perception and verbally mediated cognition enable the child to acquire knowledge about the environment as well as direct knowledge of acquaintance with the environment. The child can then be shown or be told, or be taught. But the visual mediators of second hand knowledge are only superficially understood by psychologists and educators. What we have to understand is the information about the world conveyed by pictures, motion pictures, sculptures, models, toys, exhibits, graphs, writing, print, and books.

Human artifacts can be classified as graphic or plastic, but there is no sharp division between them. Scribbling, drawing, painting, diagramming, mapping, handwriting, and printing are said to be graphic. All these involve traces on a surface. Until very recently in history, the traces had to be made by hand. The manual act of trace-making helps the child to distinguish the variables of graphic information. Some of these variables are straightness, curvature, bentness, tilt, closedness, intersection, and symmetry but there are many more of them not yet analyzed. (An attempt to discover the variables used by children to distinguish

capital letters from one another has been made by E. J. Gibson, 1965. A beginning at the psychophysics of pictorial perception has been made by Hochberg, 1962.) The variables of graphic information seem to combine into higher order variables, perhaps without limit. They are endlessly interesting even as such, whether or not they make representations or ideographs, or numerals, or alphabetic letters. The graphic artist is fascinated by them (Kepes, 1944). Even the child at 16 months of age begins to be interested in graphic information by the evidence of the experiments here reported.

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Footnote

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Table 1

Time Employed in Scribbling with Tracing and Nontracing Tools

Subject	Age (mo.)	Duration of activity (in seconds) Tracing tool	Nontracing tool	Ratio of time with nontracing to time with tracing tool
1	15	72	30	.417
2	16	22	16	.727
3	18	75	34	.453
4	22	35	15	.428
5	23	30	10	.333
6	25	72	3	.042
7	30	123	4	.033
8	30	55	29	.527
9	33	145	12	.083
10	35	90	41	.455
11	37	115	65	.565
12	37	53	5	.094
13	38	53	2	.038
14	38	64	23	.359
Mean	28	71.7	20.6	.325